

Map 10-1. Morgan County

Part X. Morgan County

Morgan County is the third smallest county in Utah in area, consisting of 610 square miles. Elevation ranges from 4,895 feet at Mountain Green to Thurston Peak at 9,706 feet. Entry into the county from the Great Salt Lake Valley is through Weber Canyon, which opens on both the east and northwest sides of the county. The landscape includes high mountains, steppe valleys, the Weber River valley, and two smaller streams, East Canyon Creek and Lost Creek, each with reservoirs in their upper reaches.

Morgan County includes one municipality Morgan City, the county seat, and ten unincorporated areas - Croydon, East Canyon Resort, Enterprise, Milton, Mountain Green, Peterson, Porterville/Richville, Round Valley, Snow Basin Resort and Stoddard. Land ownership in Morgan County is 90% private, 5% federal, 3% state and 2% underwater. Morgan County has the highest percentage of privately owned land in the state.

The Wasatch National Forest extends into the north side of the county. Summit County lies to the east and south. Davis, Weber and Salt Lake Counties are on the western border. Rich County borders on the northeast.

Morgan County's population was projected at 8,134 persons for 2006 (UPEC 2007) which are concentrated primarily in the areas of Morgan City and Mountain Green. Because of Morgan County's close proximity to Salt Lake, Davis and Weber Counties, the population is increasing rapidly. The county is expected to continue growing along the Interstate 84 corridor, with the highest concentration of new development in the southern and western portions of the county. Development is occurring in areas that once were agricultural or farmland. Morgan County prides itself in its rural setting and this is recognized in county codes and ordinances for planned development.

Historically, agriculture, mainly livestock, crop and mink pelt production, has been the primary type of economic activity in Morgan County. Recently, manufacturing, trade, government and construction have begun to diversify the economy. The principle employer is Hill Air Force Base (Morgan County Emergency Operations Plan). Some larger employers include Morgan County School District, Holcim US, Inc., Browning, IGA Grocery, Precision Supplied Components LLC, and Morgan County (UDWS 2007b). The 2005 labor force totaled 3,792 persons with 3,633 employed and 159 unemployed. Per capita income was \$26,844 and the average monthly non-farm wage for 1,831 non-farm jobs was \$2,237 (UDWS 2006). The industries with the highest total payrolls included construction, manufacturing and wholesale trade in the private sector and education and public administration in the public sector (UDWS 2006). The 2005 total wages for the county were \$49,951,005 (UDWS 2006). Total personal income in 2005 was \$191.3 million (BEA 2007).

Hazard History

Within the mitigation planning process it is important to remember that the past is the key to the future. Identifying past hazard events provide a starting point for predicting where future events could potentially occur. The following historical hazard event statistics were consolidated from the Spatial Hazard Events and Losses Database for the United States (SHELDUS) of the Hazards and Vulnerability Research Institute. The database records reported natural hazard events for Morgan County which caused greater than \$50,000 in damages. The monetary figures are in 2005 dollars.

Risk Assessment

The risk assessment process revealed the following for the identified hazards of earthquake, flood, dam failure, wildland fire, slope failure, infestation, severe weather and drought. Infestation, severe weather, radon and drought are considered to be regional hazards and can be found in Part XII. Risk assessment maps were completed for each hazard and are included in each section. Refer to Part VI for an explanation of the risk assessment process. According to this data there are a total of 7 critical facilities in Morgan County. Table 10-1 below outlines the total number of critical facilities within the county with moderate or greater levels of risk.

Number of Structures with Moderate or Greater Vulnerability (% of Total)								
Critical Facilities	Total	Dam Failure	Flood	Ground Shaking	Liquefaction	Problem Soils	Slope Failure	Wildfire
Amateur Radio Repeaters	4	0 (0%)	0 (0%)	4 (100%)	0 (0%)	0 (0%)	0 (0%)	4 (100%)
Emergency Operations Centers	1	1 (100%)	0 (0%)	1 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Fire Stations	2	1 (50%)	1 (50%)	2 (50%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Police Stations	1	1 (100%)	0 (0%)	1 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Schools	4	3 (100%)	3 (100%)	4 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)

Table 10-1. Critical Facilities Vulnerability Matrix for Local Hazards, Morgan County

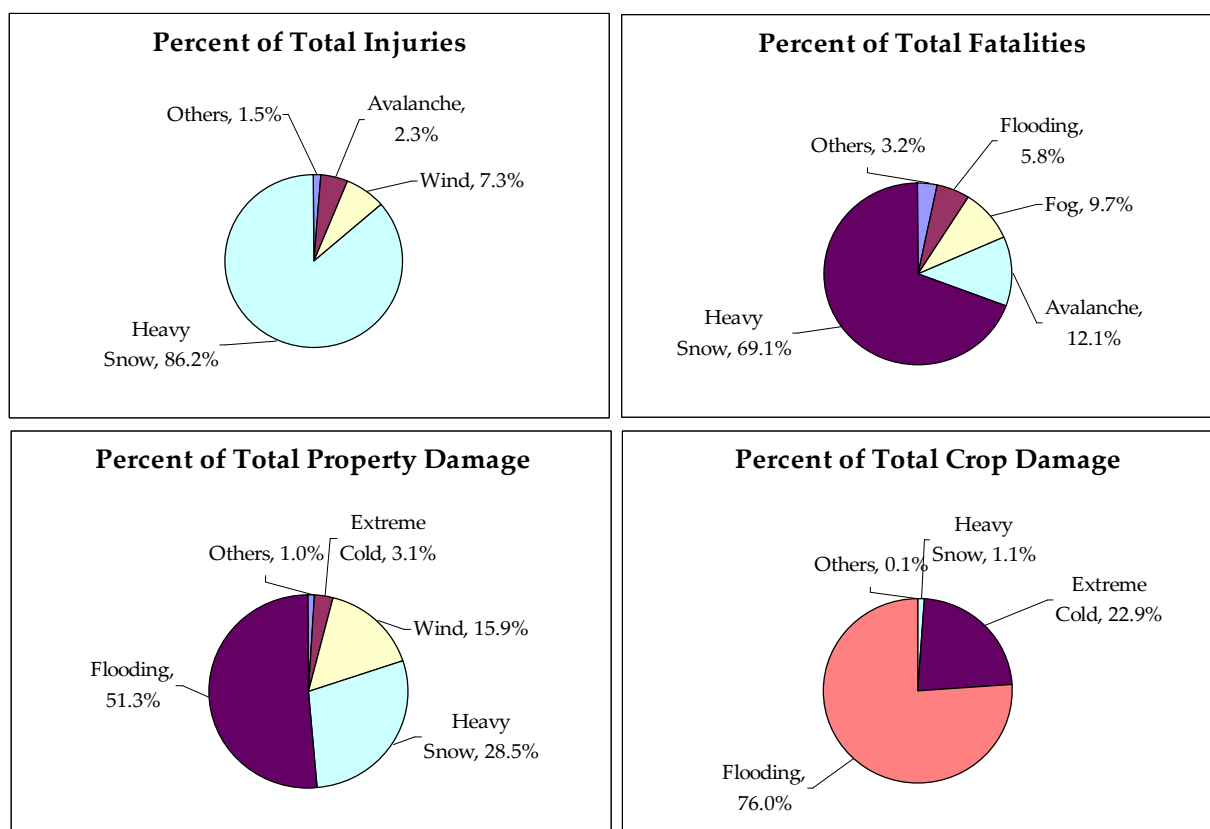


Figure 10-1. Major Disaster Event Averages 1962-2005, Morgan County (HVRI 2007)

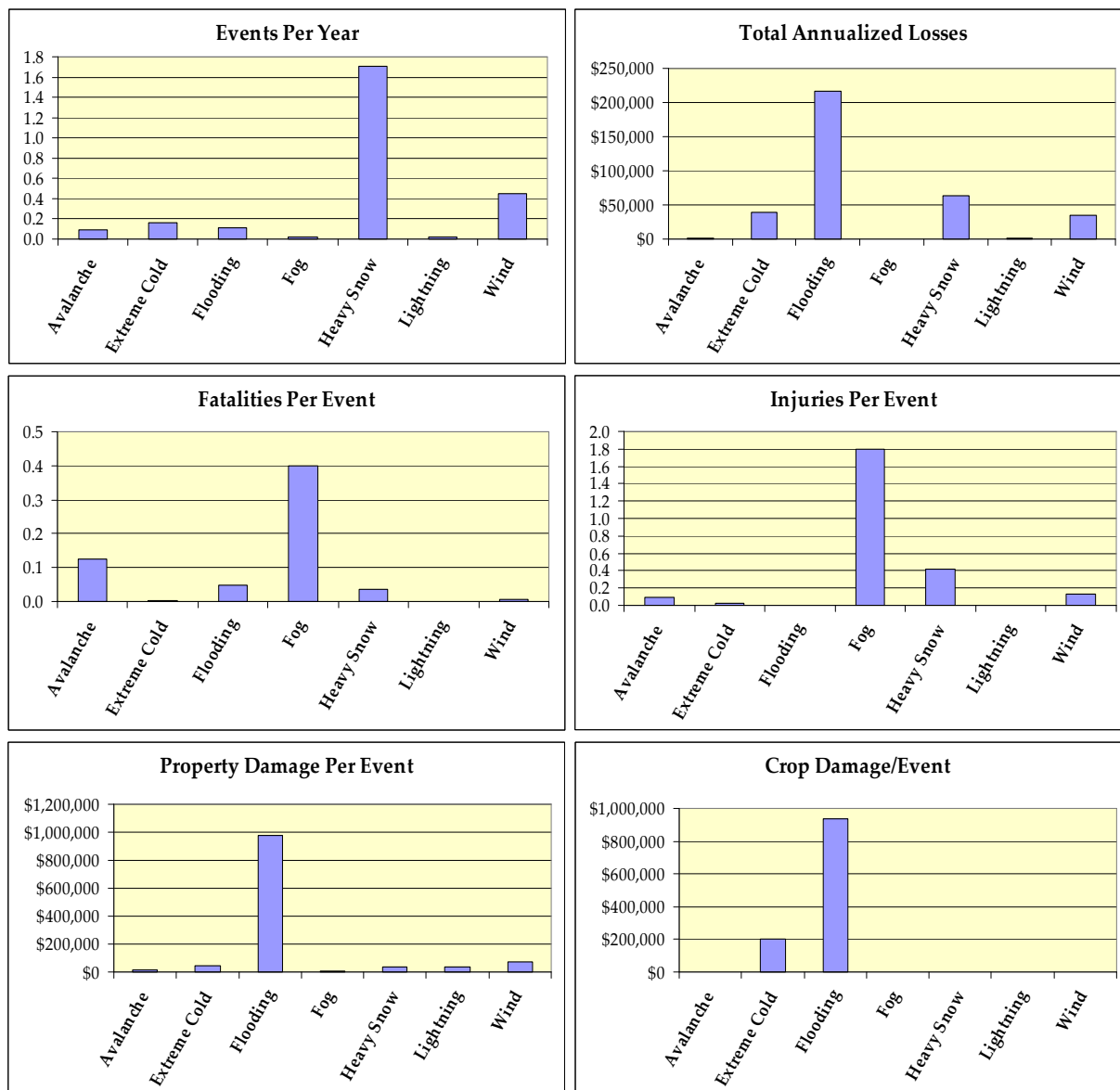


Figure 10-2. Major Disaster Annual and Per Event Averages 1962-2005, Morgan County (HVRI 2007)

1. Earthquake Hazard Profile

<i>Potential Magnitude</i>	X	Catastrophic (>50%)	<i>Probability</i>		Highly Likely
		Critical (25-50%)		X	Likely
		Limited (10-25%)			Possible
		Negligible (< 10%)			Unlikely
<i>Location</i>	Western portion of the county, which is closest to the Intermountain Seismic Belt has the highest probability of being affected by an earthquake. Ground shaking would be felt throughout the entire county. Surface fault rupture could occur in areas of known historic fault zones.				
<i>Seasonal Pattern</i>	None				
<i>Conditions</i>	Liquefaction potential exists within areas that have a high ground water table. The soil is comprised of old lakebed sediments in certain areas. Historic movement along faults is evident such as the Intermountain Seismic Zone and Wasatch Fault.				
<i>Duration</i>	Actual ground shaking will be under one minute. Aftershocks can occur for weeks or even months.				
<i>Secondary Hazards</i>	Fire, landslide, rock falls, avalanche, flooding, liquefaction.				
<i>Analysis Used</i>	Review of hazard analysis plans and other information provided by the University of Utah Seismograph Station, UGS, USGS, DHLS, AGRC. HAZUS-MH.				

Description of Location and Extent

In northern Utah, the Wasatch Fault Zone is an active fault zone that can produce a large 7.5-7.7 Richter magnitude earthquake on average every 300-400 years (UGS 2002). Morgan County is situated between two segments of the Wasatch Fault, the Weber Segment and the Salt Lake Segment.

The combined average repeat time for large earthquakes on any of the five central segments (Brigham City, Weber, Salt Lake City, Provo, and Nephi segments) of the Wasatch Fault zone is 350 years (McCalpin and Nishenko 1996 in UGS 2002). The average repeat time on any single segment ranges from about 1,200-2,600 years. Major earthquakes on the five central segments occurred 250 to 2,900 years ago (Lund 2005). The Weber Segment of the Wasatch Fault runs from North Salt Lake to Willard Bay. The Weber Segment has produced four large earthquakes over the past 4,000 years (McCalpin and Nishenko 1996, in UGS 2002), making it one of the most active fault segments. The Salt Lake Segment underlies the Salt Lake valley. Smaller fault zones also pose a threat to Morgan City; include the Morgan, East Canyon, and Salaratus Creek fault zones (UGS 2002). The best data thus far is from the Morgan Fault which has a maximum potential of a 6.5-7.0 Richter magnitude fault rupture (Hecker 1993 in UGS 2002).

The recent historical record of earthquakes in Morgan County shows no events greater than Richter magnitude 4.0. Map 10-2 (page 161) illustrates the locations of earthquakes epicenters in Morgan County since 1962, along with approximate Richter magnitude. Fault groups are provided to show relative locations of epicenters to faults located within the county.

A 0.2-second spectral acceleration map (Map 10-3 page 162) was created due to the predominance of one- and two-story buildings in the County. This frequency of ground shaking causes the greatest amount of damage in these structures (UGS 2008).

The mapped values indicate the maximum probable force (as a percentage of gravity) a one-to-two-story building would experience during a 2,500-year event (2% probability of exceedance in 50 years), which corresponds roughly to a Richter magnitude 7.1 event along the Wasatch Fault. For example, Morgan City would likely experience around 1g of lateral force during the event. Poorly constructed buildings will likely experience damage at around 0.1g (10% of gravity) (FEMA 1995). Local geologic structure and shaking duration are not accounted for in this map, and will likely cause significant variability in damages during an actual event.

Name	Fault Type	Length (km)	Time of most recent deformation	Recurrence Interval
East Canyon (East Side) fault	Unknown	24	<1.6 million years ago	Unknown
East Canyon fault, Northern section	Normal	25.9	<1.6 million years ago	Unknown
East Canyon fault, Southern section	Normal	25.9	<750,000 years ago	Unknown
Morgan fault, Central section	Normal	16.6	<8320±100 14C yr B.P.	25,000-100,000 years
Morgan fault, Northern section	Normal	16.6	<750,000 years ago	Unknown
Morgan fault, Southern section	Normal	16.6	<750,000 years ago	Unknown
Saleraus Creek fault	Normal	38	<750,000 years ago	Unknown

Table 10-2. Active Faults in Morgan County (UGS 2002, Lund 2005) 14C yr B.P.=Radiocarbon 14 years before present

Liquefaction hazard for Morgan County is low (Map 10-4 page 163). The river valleys have a minimal risk. This does not minimize the effect that an earthquake will have on the County as the ground shaking risk remains high.

Vulnerability Analysis

A vulnerability analysis was obtained from the modeling program Hazards United States – Multi-hazards (HAZUS-MH)**. The following numbers were based on a probabilistic 2,500-year event with a Richter magnitude of 7.1. An arbitrary 5.9 event located in close proximity to the County’s most populated areas was also modeled. These locations and magnitudes were chosen for their likelihood and proximity respectively. Default HAZUS-MH inventory for all infrastructure was used. (**For a more detailed explanation of the loss estimation methodology of HAZUS-MH, please see Part VII or the HAZUS-MH Technical Manual (Earthquake Model) at www.fema.gov/hazus).

Building Damage

HAZUS-MH classifies building damage into five states: none, slight, moderate, extensive and complete. Table 10-3 lists the number of buildings by occupancy estimated to sustain moderate to complete levels of damage. Also listed are the estimated monetary losses to structures, contents/inventory and income.

Category	Number of Structures		Category	Estimated Losses	
	Morgan M5.9	2500-yr M7.1		Morgan M5.9	2500-yr M7.1
Residential	80	758	Structural Losses	\$1,023,000	\$11,772,580
Commercial	4	24	Non-Structural Losses	\$3,600,000	\$37,701,470
Industrial	1	8	Content Losses	\$1,439,000	\$12,760,820
Government	1	9	Inventory Losses	\$76,000	\$717,160
Education	0	1	Income & Relocation Losses	\$909,000	\$10,179,540
Totals	86	800	Totals	\$7,047,000	\$72,414,410
Table 10-3. Building Damage Counts and Estimated Losses					

Transportation and Utilities Damage

Damages to transportation and utility infrastructure are in Table 10-4. Infrastructure sustaining moderate or worse damage and estimated monetary losses are both shown.

Category	Total	At Least Moderate Damage >50%		Estimated Losses	
		Morgan M5.9	2500-yr M7.1	Morgan M5.9	2500-yr M7.1
Waste Water Facilities	2	1	2	\$16,313,000	\$36,722,000
Waste Water Pipelines	735 km	38 leaks/breaks	801 leaks/breaks	\$137,000	\$2,886,000
Potable Water Pipelines	1,225 km	48 leaks/breaks	1,014 leaks/breaks	\$173,000	\$3,649,000
Natural Gas Pipelines	490 km	41 leaks/breaks	857 leaks/breaks	\$146,000	\$3,085,000
Highway Bridges	80	13	31	\$1,419,000	\$10,842,000
Railway Bridges	1	0	0	\$0	\$4,000
Airport Facilities	1	0	1	\$1,273,000	\$2,157,000
Total Losses				\$19,461,000	\$59,345,000
Table 10-4. Damage to Transportation and Utilities					

Debris Removal

Table 10-5 shows how much debris would be generated by the earthquake and how many loads it would take to remove the debris, based on 25 tons per load. One truck can likely haul one load per hour. A second debris removal issue is landfill space. Fifty thousand tons at a weight-to-volume ratio of one ton per cubic yard would cover more than ten acres to a depth of three feet.

Category	Morgan M5.9	2500-yr M7.1
Brick, Wood & Others	1,000 tons / 40 loads	12,000 tons / 480 loads
Concrete & Steel	2,000 tons / 80 loads	27,000 tons / 1,080 loads
Table 10-5. Debris Generated/Number of Loads		

Fire Following

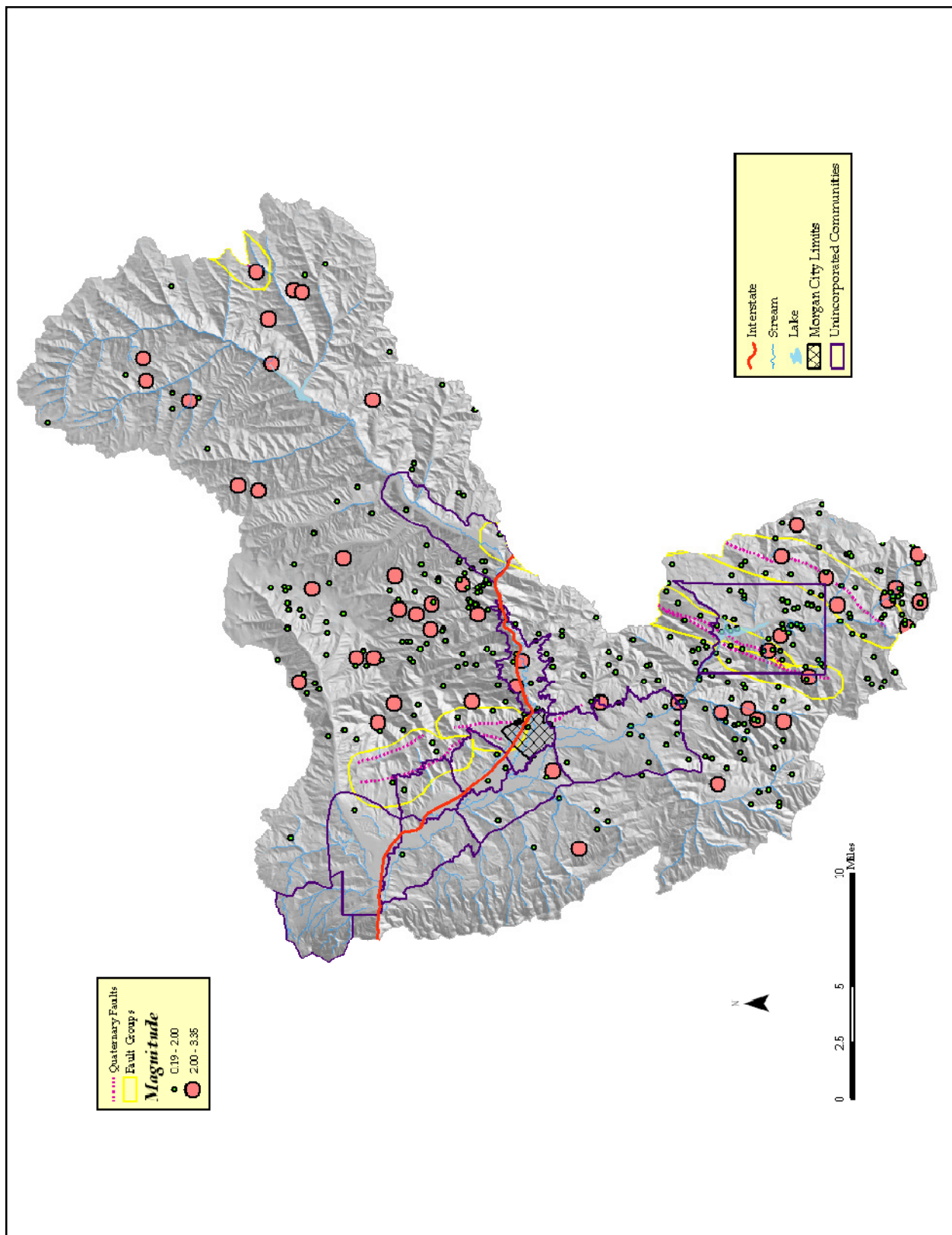
Multiple ignitions and broken water mains following an earthquake can make firefighting nearly impossible. HAZUS-MH uses estimated building damages, loss of transportation infrastructure and estimated winds to calculate the estimated area that would be burned following an earthquake. Table 10-6 provides estimates of ignitions, people at risk and the building stock exposed to fires following an earthquake.

Category	Number of Structures	
	Morgan M5.9	2500-yr M7.1
Ignitions	0	0
Persons Exposed	0	0
Value Exposed	\$0	\$0
Table 10-6. Fire Following Event, Population Exposed, and Building Stock Exposed		

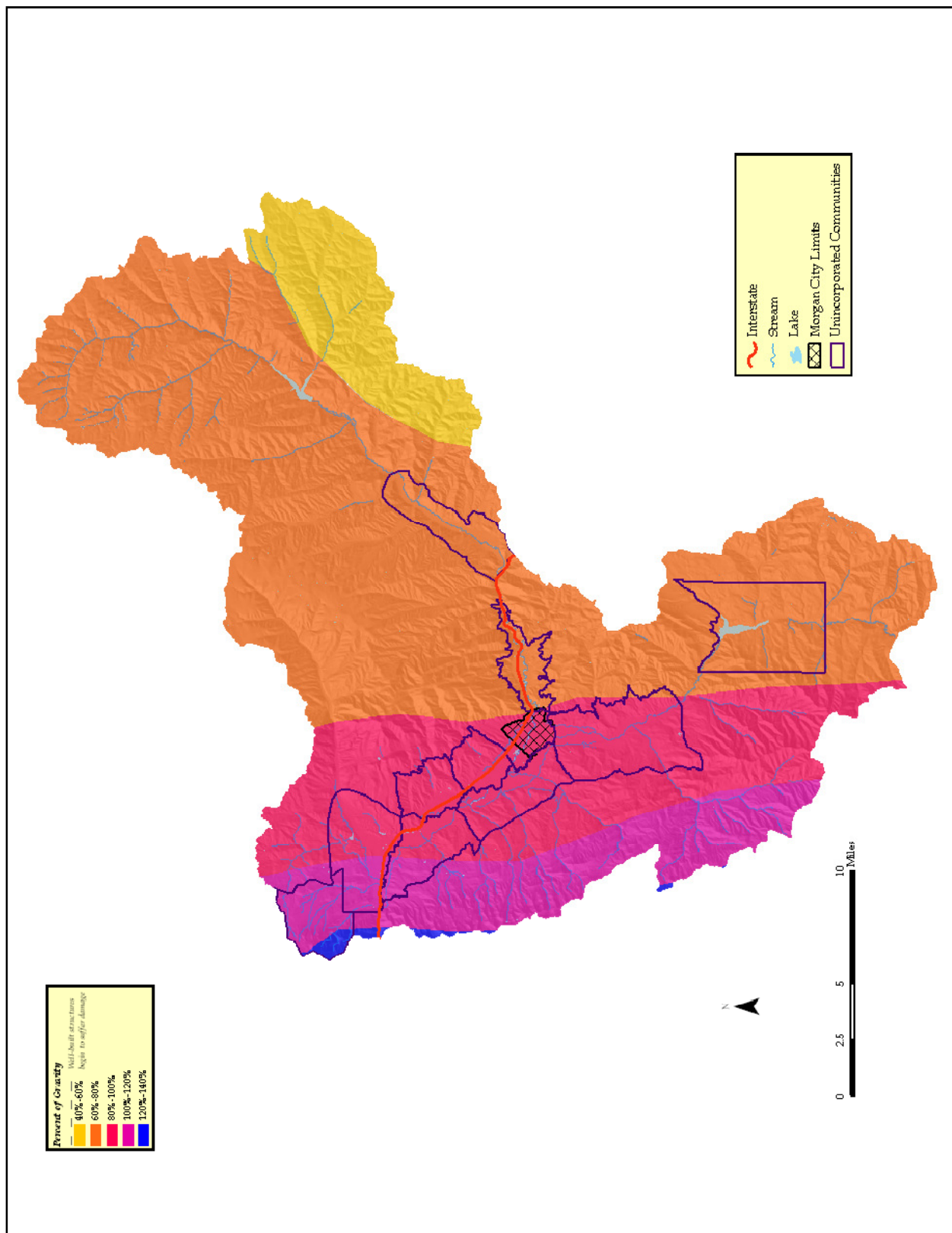
Casualties

Table 10-7 estimates casualties likely to occur during each earthquake scenario. The nighttime scenario (2 a.m. local time) assumes a primarily residential concentration of persons. The daytime scenario (2 p.m. local time) assumes a commercial concentration. The commute scenario (5 pm. local time) assumes a concentration of persons on commuting routes. Categories of casualties include those not requiring hospitalization (minor), those requiring treatment at a medical facility (major) and fatalities.

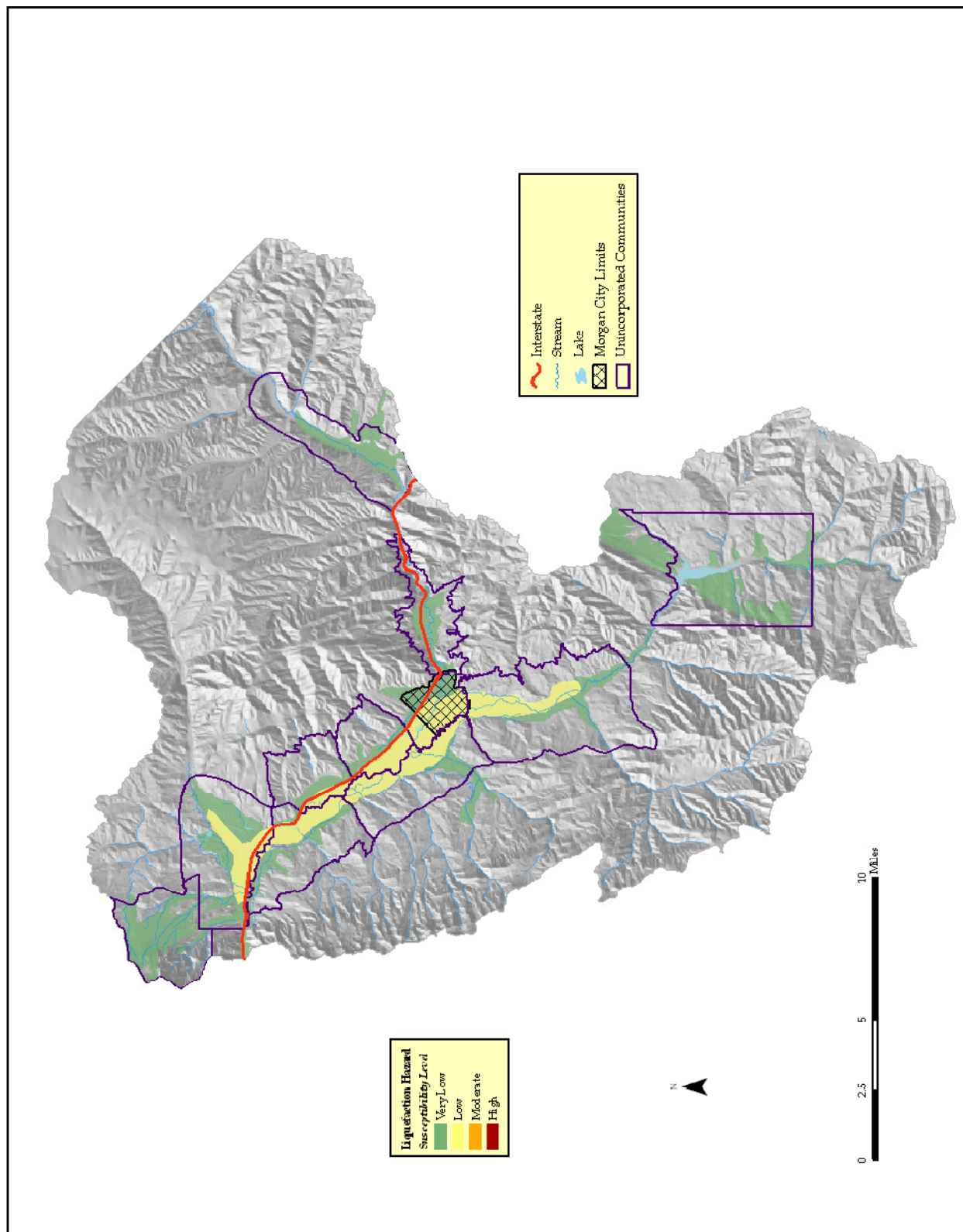
Night Event	Morgan M5.9	2500-yr M7.1	Day Event	Morgan M5.9	2500-yr M7.1	Commute Event	Morgan M5.9	2500-yr M7.1
Minor	2	30	Minor	2	42	Minor	2	35
Major	0	8	Major	0	14	Major	0	10
Fatalities	0	2	Fatalities	0	4	Fatalities	0	3
Table 10-7. Casualties								



Map 10-2. Historical Earthquake Epicenters and Faults, Morgan County 1900-2007 (UOSS 2007)



Map 10-3. Ground Shaking Hazard Map, Morgan County (NSHMP 2002)



Map 10-4. Liquefaction Hazard Map, Morgan County (Solomon, et. al 2004)

2. Flood

Hazard Profile

<i>Potential Magnitude</i>		<i>Catastrophic (>50%)</i>	<i>Probability</i>		<i>Highly Likely</i>
	X	<i>Critical (25-50%)</i>		X	<i>Likely</i>
		<i>Limited (10-25%)</i>			<i>Possible</i>
		<i>Negligible (< 10%)</i>			<i>Unlikely</i>
<i>Location</i>	Weber River and its tributaries.				
<i>Frequency</i>	Spring, late summer.				
<i>Conditions</i>	Cloudburst Storms and Heavy Snowfall Runoff.				
<i>Duration</i>	Flooding can last anywhere from hours to days and even months.				
<i>Secondary Hazards</i>	Raw sewage/health risk, electrical fires, gas spills.				
<i>Analysis Used</i>	Review of FIS, FIRM, HAZUS-MH.				

Description of Location and Extent

Flooding is largely associated with heavy rainfall from cloudburst storms. Morgan County has also experienced rapid snowpack melt, resulting in flooding and flash flooding. Historical events suggest flooding poses the most significant reoccurring threat. Unusually heavy rain and snowpack can result in flooding, mud, debris flows and avalanches on steep slopes near the foothills.

The Weber River and its tributaries (East Canyon Creek, Lost Creek, Hardscrabble, Deep Creek and Peterson Creek) pose the most significant flood threat (Map 10-5 page 166). Lost Creek has experienced flooding because bridges become obstructed with debris acting as a dam. Gordon Creek has also flooded in the past due to a perched channel. Sewer and water lines cross the Weber River and the spring flooding of 1983 caused a sewer line to break. This sewer line is now encased with concrete so should no longer pose a problem. Another flood event similar to those of 1952 and 1983-1984 could cause the Como Bridge to fail due to age. A 100-year flood event would cause Deep Creek to experience overbank flooding. Agricultural flooding is also of concern because of the amount of farmlands and irrigation canals.

Island Road along East Canyon Creek through Richville, as well as the Highlands and Mountain Green between I-84 and the old highway could experience residential and commercial flooding. Morgan High, Junior, Middle and Morgan County Elementary Schools are all located in the floodplain, as is the entire city of Morgan. See Map 10-5 for the flood hazard in Morgan County.

Vulnerability Assessment

The vulnerability assessment for flooding in Morgan County was obtained from HAZUS-MH**. Vulnerability was assessed for both 100-year (NFIP Zone A) and 500-year (NFIP Zone B or Zone X (shaded)) flood events. Total monetary losses include structures, contents and business interruption. Analysis was completed using Flood Insurance Rate Maps (FIRM). Only streams which contained detailed flood cross-section data could be used. Consequently, the results should be considered conservative. (**For a more detailed explanation of the loss estimation methodology of HAZUS-MH MR2, please see Part VI or the HAZUS-MH Technical Manual (Flood Model) at www.fema.gov/hazus)

	Acres Flooded	Population Displaced	Number of Structures with at Least Moderate Damage	
			<i>Residential Units (Total Losses)</i>	<i>Commercial/Industrial Units (Total Losses)</i>
100-year Flood	3019.72	539	117 \$6,370,000	0 \$2,850,000
500-year Flood	3259.56	595	130 \$8,050,000	0 \$3,480,000

Table 10-8. Morgan County Flood Hazard

Agricultural Losses

Agricultural losses are listed in Table 10-9. Losses are computed according to the number of days in which the crops are inundated with water. All numbers are estimated for a flood occurring near April 15th.

	100-year Losses Day 3	100-year Losses Day 7	500-year Losses Day 3	500-year Losses Day 7
Barley	\$23,375	\$31,167	\$24,332	\$32,442

Table 10-9. Agricultural Losses, April 15th Scenario

Vehicle Losses

Table 10-10 contains losses for vehicles in floods during both daytime and nighttime scenarios. The scenarios assume ninety percent (90%) of vehicles being removed from hazard areas due to warning.

Category	100-year	500-year
<i>Daytime Scenario</i>	\$416,921	\$518,385
<i>Nighttime Scenario</i>	\$521,329	\$637,730

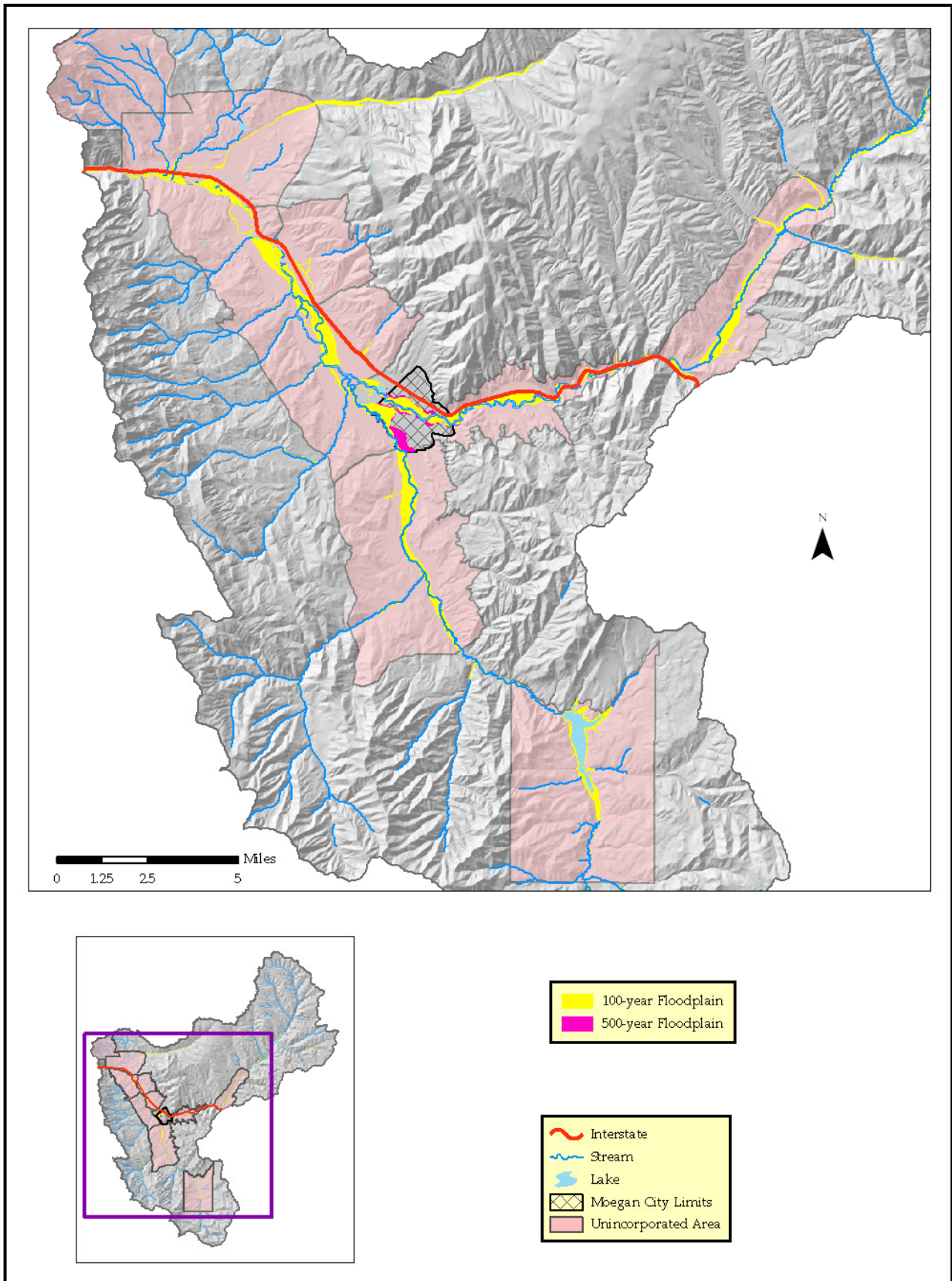
Table 10-10. Vehicle Losses

Debris Removal

Table 10-11 shows how much debris would be generated by flooding and how many loads it would take to remove the debris, based on a capacity of 25 tons per load. One truck can likely haul one load per hour. A second debris removal issue is landfill space. Fifty thousand tons at a weight-to-volume ratio of one ton per cubic yard would cover more than ten acres to a depth of three feet.

Category	100-year	500-year
<i>Finishes</i>	759 tons/31 loads	940 tons/38 loads
<i>Structures</i>	110 tons/5 loads	124 tons/ 5 loads
<i>Foundations</i>	118 tons/5 loads	135 tons/6 loads
<i>Totals</i>	987 tons/41 loads	1,199 tons/49 loads

Table 10-11. Debris Generation and Removal



Map 10-5. 100-year (NFIP Zone A) and 500-Year Floodplains (NFIP Zone B) (NFIP 1990a)

3. Slope Failure

Hazard Profile

<i>Potential Magnitude</i>		<i>Catastrophic (>50%)</i>	<i>Probability</i>		<i>Highly Likely</i>
	X	<i>Critical (25-50%)</i>		X	<i>Likely</i>
		<i>Limited (10-25%)</i>			<i>Possible</i>
		<i>Negligible (< 10%)</i>			<i>Unlikely</i>
<i>Location</i>	See Map 10-6.				
<i>Frequency</i>	Spring and summer; after heavy or long-duration precipitation.				
<i>Conditions</i>	Usually caused by the stress release of over-weighted soils, shallow groundwater in certain soils, or loosening of rock and debris.				
<i>Duration</i>	Hours to years.				
<i>Secondary Hazards</i>	Flooding (natural dams), traffic accidents.				
<i>Analysis Used</i>	Information and maps provided by UGS, DHLS.				

Description and Extent

Landslides are a significant hazard in Morgan County due to the prevalence of clay soils and ample precipitation. Clay soils can hold much water. Morgan County's mountainous terrain allows for a substantial annual snowpack and high water table. This groundwater acts as an excellent lubricant allowing the soils to slide.

With increasing residential development, many prime building sites are now located on top of these soils, especially in the Mountain Green and Peterson areas (see Map 10-6 page 169). Notable active landslides are found along Creekside Drive in Mountain Green. Slides occurred in 2001 and 2005-2006 causing over \$1 million dollars in damages to homes, roads and utilities in the latter event (Elliot 2007b).



Rock fall near Devil's Slide, March 2004 (UGS 2004)

Another slope failure hazard in Morgan County is rock fall. The freezing and thawing of water trapped between cracks in rock formations can cause the rock to break apart. Gravity then takes over causing the rocks to fall downhill. This occurred in March of 2004, near Devil's Slide, when a large boulder dislodged from a high cliff breaking into several pieces. The largest of these weighed close to 250 tons and rolled down the hill nearly half mile before coming to rest (Elliot 2007b).

Vulnerability Assessment

Table 10-12 estimates infrastructure vulnerable to landslides in Morgan County. Provided are the number of units or total length of infrastructure vulnerable and the estimated replacement costs as provided by HAZUS-MH lost estimation software.

Table 10-13 estimates the total area, population, and buildings vulnerable to landslides for individual cities and unincorporated areas. Rail bridge vulnerability accounts only for the State Street Bridge in Morgan City. Major repair or replacement of Weber Basin Water Conservancy District (WBWCD) water distribution infrastructure would likely cost several millions of dollars in excess of that listed below.

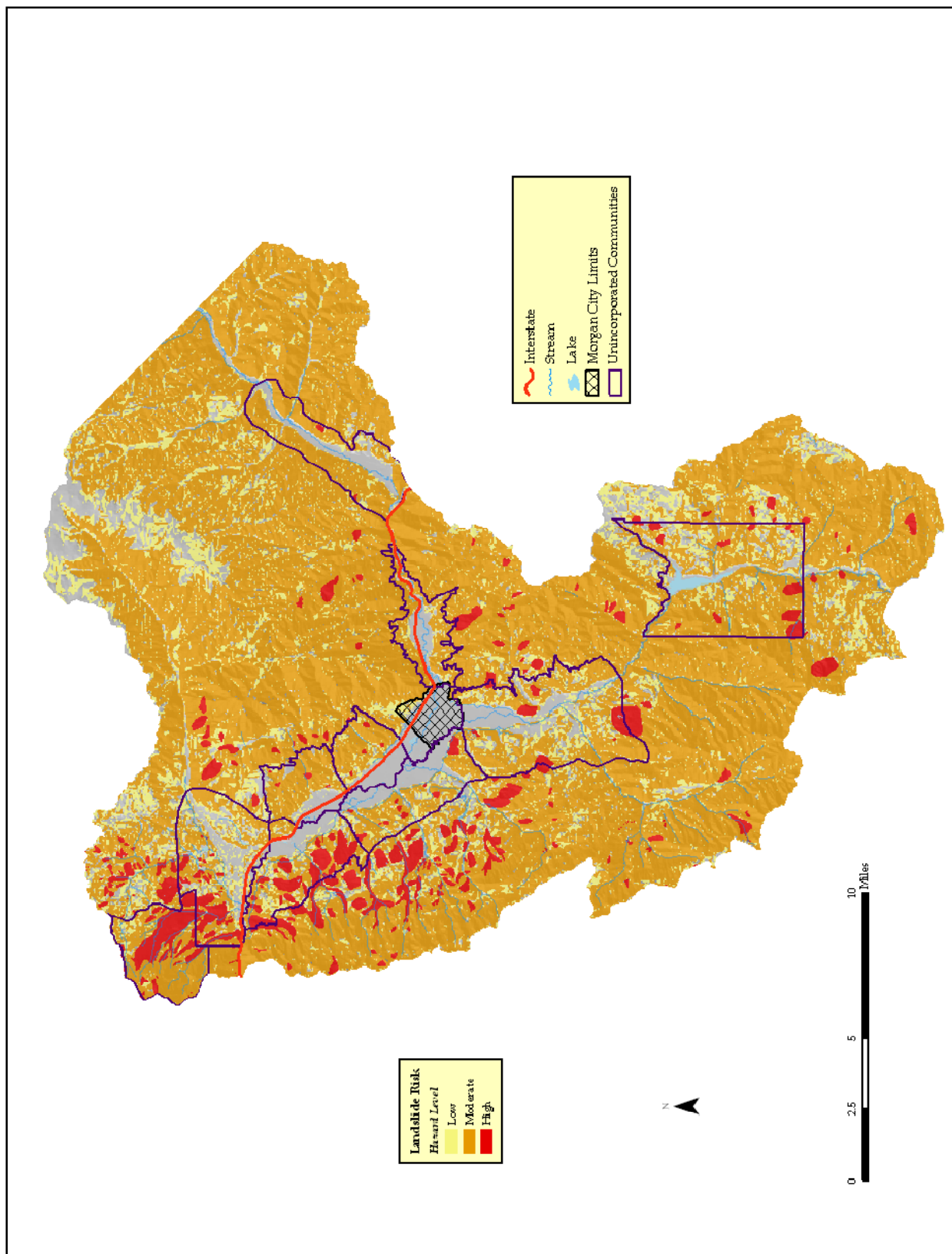
Item	Length (Miles) or Number of Units	Replacement Cost
Highways/Interstates	16.5 miles	\$89,387,083
Highway Bridges	39 bridges	\$43,348,782
Railway Segments	4.92 miles	\$5,652,768
Railway Bridges	0 bridges	\$0
Water Distribution Lines	904.90 miles	\$18,099,375
Gas Lines	224.87 miles	\$7,239,760
Sewer Lines	337.34 miles	\$10,859,637
Total Estimated Infrastructure Replacement Cost		\$174,587,405

Table 10-12. Infrastructure Vulnerable to Landslides, Morgan County

Incorporated	Acres in Hazard Area	Population in Hazard Area	Structures in Areas of Moderate or Greater Hazard	
			Residential Units (Replacement Cost)	Commercial Units (Annual Sales)
Morgan City	74	231	73 \$14,819,000	0

Unincorporated	Acres in Hazard Area	Population in Hazard Area	Structures in Areas of Moderate or Greater Hazard	
			Residential Units (Replacement Cost)	Commercial Units (Annual Sales)
Croydon	4,298.0	84	28 \$5,684,000	3 \$467,080
East Canyon Resort	9,216.1	0	0	0
Enterprise	2,355.9	209	69 \$14,007,000	1 \$5,301
Milton	2,822.5	690	230 \$46,690,000	1 \$12,489
Mountain Green	4,166.3	1,267	401 \$81,403,000	18 \$4,060,753
Peterson	3,658.3	440	156 \$31,668,000	2 \$1,798,602
Porterville/Richville	6,753.2	694	226 \$45,878,000	4 \$376,274
Round Valley	2,248.3	213	79 \$16,037,000	3 \$1,103,913
Snow Basin Resort	5,189.5	0	0	0
Stoddard	1,767.9	188	61 \$12,383,000	1 \$448,400

Table 10-13. Morgan County Landslide Vulnerability



Map 10-6. Morgan County Landslide Hazard (Giraud and Shaw 2007)

4. Wildland Fire

Hazard Profile

<i>Potential Magnitude</i>		<i>Catastrophic (>50%)</i>	<i>Probability</i>		<i>Highly Likely</i>
	X	<i>Critical (25-50%)</i>		X	<i>Likely</i>
		<i>Limited (10-25%)</i>			<i>Possible</i>
		<i>Negligible (< 10%)</i>			<i>Unlikely</i>
<i>Location</i>	Wildland-Urban Interface (WUI) areas near the foothills and in forested areas.				
<i>Frequency</i>	Summer months				
<i>Conditions</i>	Areas affected by drought and/ or heavily overgrown with dry brush and debris Lightning and human triggers.				
<i>Duration</i>	Wildfires typically last days but can last months, depending on climate and fuel load as well as resources (financial, manpower) to extinguish the fire.				
<i>Secondary Hazards</i>	Landslides, debris flows, erosion, traffic accidents, air pollution.				
<i>Analysis Used</i>	Review of plans and data provided by US Forest Service, National Climate Center, FEMA, AGRC, County Hazard Analysis Plans, and DHLS.				

Description of Location and Extent

According to the Northern Utah Regional Wildfire Protection Plan, Morgan County experienced 444 fires during the period from 1973 to 2005 (UDFFSL 2007). Many of these fires occur in wildland areas. The threat of wildfires is steadily increasing in Morgan County. Residential development is spreading further into WUI areas each year with building permits in Morgan County up 21% in 2007 from the year prior (BEBR 2007).

The wildfire threat has had a significant effect on the County watersheds, including landslides, debris flows and other forms of erosion. Federal, state and local agencies have worked together to enforce ordinances and other programs to protect watersheds.

Wildland fire risk is found in Map 10-7 (page 172). The map layers were provided by the Utah Division of Forestry, Fire and State Lands and show four categories of wildfire risk (extreme, high, moderate, and low). These ratings cover all of Morgan County and are based on the type and density of vegetation in each area as well as the vulnerable population. Additional factors that influence fires (weather conditions, wind speed and direction) are not considered in this risk assessment.

Large areas of the County are at moderate or greater wildland fire risk. Morgan City has a low risk within most of its boundaries. A small area in the northern part of the city has extreme wildland fire risk. Unincorporated areas primarily affected include Enterprise, Milton, Mountain Green, Peterson, Snow Basin Resort and Stoddard. Development has been advancing further into WUI zones, with many of the most vulnerable homes also the most costly to replace. Without effective fuel reduction measures and sufficient defensible space, these areas may likely experience considerable losses.

Vulnerability Assessment

Table 10-14 estimates infrastructure vulnerable to wildland fire in Morgan County. Provided are the number of units or total length of infrastructure vulnerable and the estimated replacement costs as provided by HAZUS-MH lost estimation software. Table 9-15 estimates the total area, population and buildings vulnerable to wildland fire for individual cities and unincorporated areas. Rail bridge vulnerability accounts only for the State Street Bridge in Morgan City.

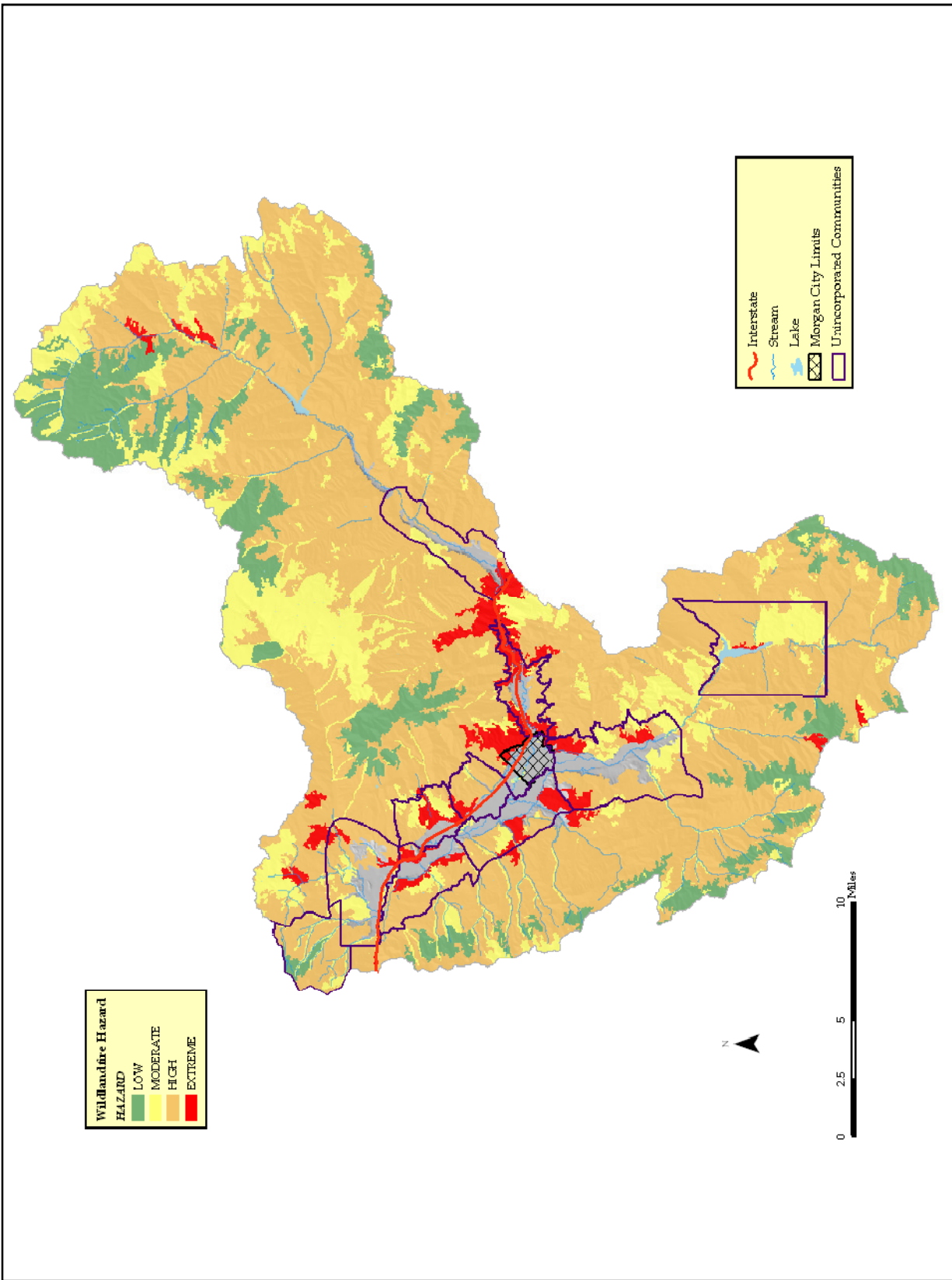
Item	Length (Miles) or Number of Units	Replacement Cost
Highways/Interstates	46.49 miles	\$290,734,600
Highway Bridges	10 bridges	\$2,878,644
Railway Segments	33.22 miles	\$38,159,858
Railway Facilities	1 bridge	\$44,100
Water Distribution Lines	N/A	N/A
Gas Lines	N/A	N/A
Sewer Lines	N/A	N/A
<i>Total Estimated Infrastructure Replacement Cost</i>		\$331,817,202

Table 10-14. Infrastructure Vulnerable to Wildland Fire, Morgan County

Incorporated	City Area (Acres)	Population in Hazard Area	Structures in Areas of Moderate or Greater Hazard	
			Residential Units (Replacement Cost)	Commercial Units (Annual Sales)
Morgan City	1,934.8	39	30 \$10,781,000	1 \$450,948

Unincorporated	Acres in Hazard Area	Population in Hazard Area	Structures in Areas of Moderate or Greater Hazard	
			Residential Units (Replacement Cost)	Commercial Units (Annual Sales)
Croydon	6,622.0	83	27 \$5,481,000	3 \$467,080
East Canyon Resort	13,462.3	0	118 \$23,954,000	1 \$80,217
Enterprise	3,696.7	28	10 \$2,885,000	5 \$344,367
Milton	5,912.7	628	196 \$39,642,500	3 \$132,465
Mountain Green	8,206.1	2,003	625 \$126,250,000	5 \$1,774,996
Peterson	5,935.1	542	169 \$34,138,000	8 \$1,951,788
Porterville/Richville	12,164.2	175	55 \$11,110,000	2 \$874,405
Round Valley	3,812.4	34	10 \$2,205,000	4 \$1,421,129
Snow Basin Resort	5,643.5	0	0	0
Stoddard	3,309	43	14 \$2,828,000	3 \$308,477

Table 10-15. Morgan County Wildland Fire Vulnerability



Map 10-7. Wildfire Hazard Map, Morgan County (UDFFSL 2007)

5. Problem Soils

Hazard Profile

<i>Potential Magnitude</i>		<i>Catastrophic (>50%)</i>	<i>Probability</i>		<i>Highly Likely</i>
		<i>Critical (25-50%)</i>			<i>Likely</i>
	X	<i>Limited (10-25%)</i>		X	<i>Possible</i>
		<i>Negligible (< 10%)</i>			<i>Unlikely</i>
<i>Location</i>	See Map 10-8 (page 175).				
<i>Frequency</i>	Continuous.				
<i>Conditions</i>	Conditions vary by geologic formation.				
<i>Duration</i>	Minutes to years.				
<i>Secondary Hazards</i>	Flooding (broken water pipes), fire (broken gas pipes).				
<i>Analysis Used</i>	Utah Geological Survey.				

Description of Location and Extent

Problem soils pose a significant threat to Morgan County. Expansive soils not only contribute to the landslide hazard, but may also cause subsidence or upheaval under building foundations, pipes and roads (Kaliser 1972). Limestone can erode into karst structures leaving a subsurface cavity vulnerable to collapse.

The primary type of expansive soil in Morgan County is clay. This soil can absorb significant quantities of water. When a home or road is placed over top of these soils, normal evaporation cannot take place. The clay begins to absorb more water than is evaporated and begins to expand causing heaving. During especially dry periods, these soils can contract significantly causing subsidence and ground cracking. Residents already living in these areas should avoid excessive watering, make sure sufficient water drainage is in place around the home, and plumbing and irrigation piping and fixtures are well protected from breakage or leaks (Kaliser 1972).

Limestone karst structures are easily eroded by water and therefore often form caverns and crevices. If these caverns become large enough, the overlying ground can give way causing sink holes and other forms of subsidence. Structures directly over the karst structure have a high potential for collapse. Ground water contamination is also possible (Mulvey 1992). Fortunately, many of the karst structures are located in undeveloped areas.

Vulnerability Assessment

Table 10-16 estimates infrastructure vulnerable to problem soils in Morgan County. Provided are the number of units or total length of infrastructure vulnerable and the estimated replacement costs as provided by HAZUS-MH lost estimation software. Table 10-17 estimates the total area, population and buildings vulnerable to landslides for individual cities and unincorporated areas. Rail bridge vulnerability accounts only for the State Street Bridge in Morgan City.

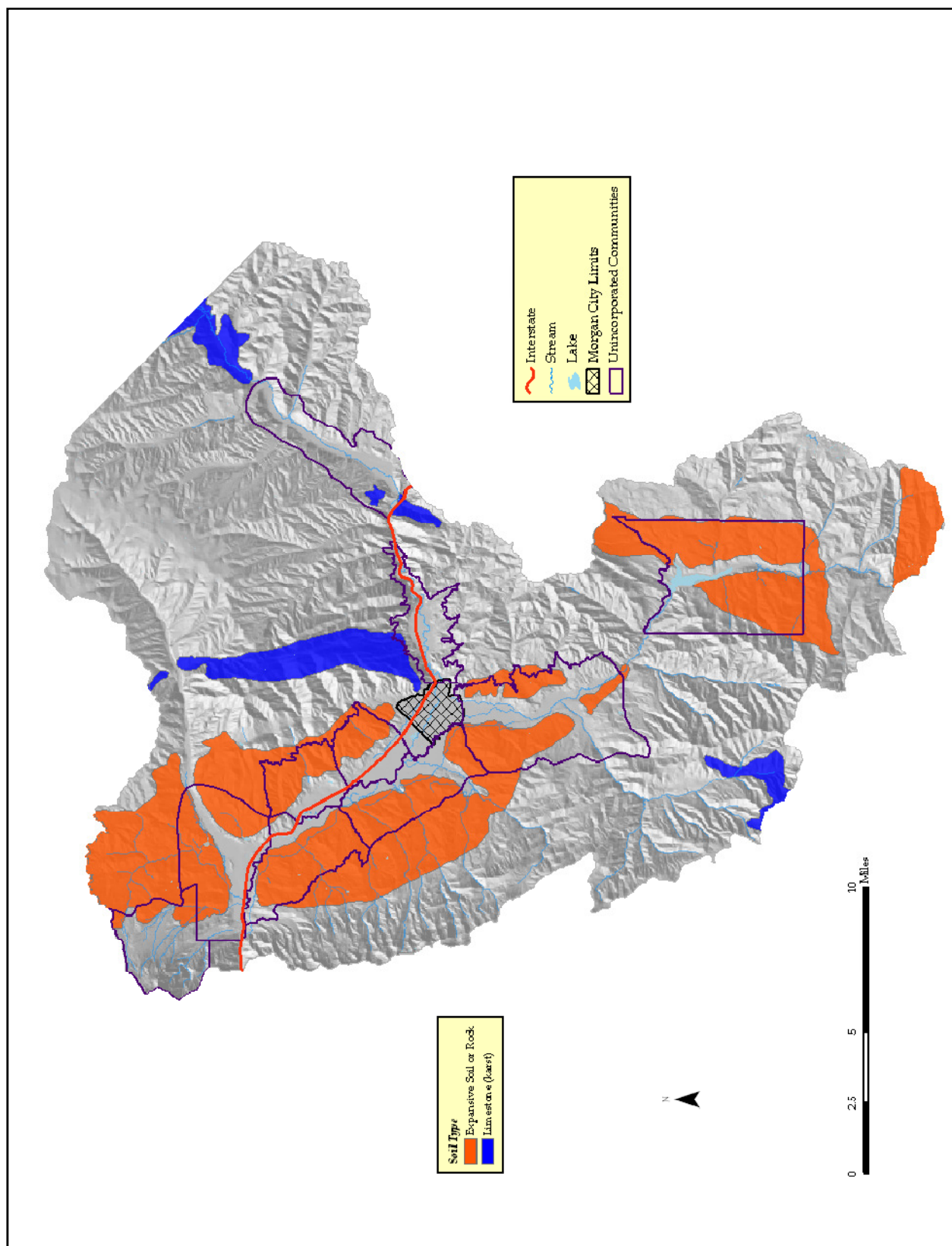
Item	Length (Miles) or Number of Units	Replacement Cost
Highways/Interstates	9.93 miles	\$45,758,668
Highway Bridges	7 bridges	\$3,974,239
Railway Segments	0.39 miles	\$446,720
Railway Bridges	0 bridges	\$0
Water Distribution Lines	153.02 miles	\$4,925,119
Gas Lines	61.21 miles	\$1,970,050
Sewer Lines	91.81 miles	\$2,955,075
Total Estimated Infrastructure Replacement Cost		\$60,029,871

Table 10-16. Infrastructure Vulnerable to Problem Soils, Morgan County

Incorporated	Acres in Hazard Area	Population in Hazard Area	Number of Structures in Hazard Area	
			Residential Units (Replacement Cost)	Commercial Units (Annual Sales)
Morgan	1	4	4 \$812,000	0

Unincorporated	Acres in Hazard Area	Population in Hazard Area	Number of Structures in Hazard Area	
			Residential Units (Replacement Cost)	Commercial Units (Annual Sales)
Croydon	4,298	0	0	3 \$467,080
East Canyon Resort	19,342	0	15 \$3,045,000	0
Enterprise	9,479	148	52 \$10,556,000	1 \$5,301
Milton	26,440	767	258 \$52,374,000	1 \$12,489
Mountain Green	20,801	751	235 \$47,705,000	18 \$4,060,753
Peterson	20,616	376	130 \$26,390,000	2 \$1,798,602
Porterville/Richville	6,753	694	226 \$45,878,000	4 \$376,274
Round Valley	2,317	12	3 \$609,000	3 \$1,103,913
Snow Basin Resort	12,457	0	0	0
Stoddard	4,020	123	41 \$8,323,000	1 \$448,400

Table 10-17. Problem Soils Vulnerability, Morgan County



Map 10-8. Problem Soils Hazard, Morgan County (Mulvey 1992)

5. Dam Failure

Hazard Profile

Potential Magnitude	X	Catastrophic (>50%)	Probability		Highly Likely
		Critical (25-50%)			Likely
		Limited (10-25%)		X	Possible
		Negligible (< 10%)			Unlikely
Location	See Map 10-9, page 178.				
Frequency	Rainy Day Failure: Spring, Late Summer Sunny Day Failure: Anytime				
Conditions	Rainy-day failure happens mainly during heavy precipitation events, can have some warning time. Sunny day failure happens without warning usually resulting from sudden structural failure.				
Duration	Hours to days.				
Analysis Used	Review of BOR inundation maps and plans, FIS, Utah Division of Water Rights.				

Description of Location and Extent

Twenty-seven dams and irrigation impoundments are located in Morgan County. Four of these dams are listed as a high hazard threat, meaning if they fail, they have a high probability of causing loss of life and extensive economic loss. Three dams have a moderate hazard threat. If they fail they have a low probability of causing loss of life, but would cause appreciable property damage. Mitigation efforts should be developed and pursued for these dams. Fifteen dams have a low hazard threat. If they were to fail there would be minimal threat to life and economic losses would be minor and damages would be limited to the owner of the dam. These dams should still be monitored. No hazard rating is provided for five dams.

It should be noted that Dam Safety hazard classifications are in the event of the failure of a dam, based upon the consequences of failure of the dam given by the State engineer. Therefore, the classification of a high hazard dam does not mean that the dam has a high probability of failure. For a list of high and moderate rated dams in Morgan County, please see Table 10-18 below. Dam locations can be found in Map 10-9 on page 178.

Name/Owner	Hazard Rating
Northwest	High
Wilkinson (Harry)	High
BOR East Canyon	High
BOR Lost Creek	High
Wardell Reservoir	Mod
Peterson Creek – Left Fork (Bohman Dam)	Mod
Morgan Secondary Water Assoc.	Mod

Table 10-18. High and Moderate Hazard Dams, Morgan County (Source: Utah Division of Water Rights)

Vulnerability Assessment

Table 10-19 estimates infrastructure vulnerable to dam failure in Morgan County. Provided are the number of units or total length of infrastructure vulnerable and the estimated replacement costs as provided by HAZUS-MH lost estimation software. Table 10-20 estimates the total area, population and buildings vulnerable to dam failure for individual cities and unincorporated areas. Rail bridge vulnerability accounts only for the State Street Bridge in Morgan City.

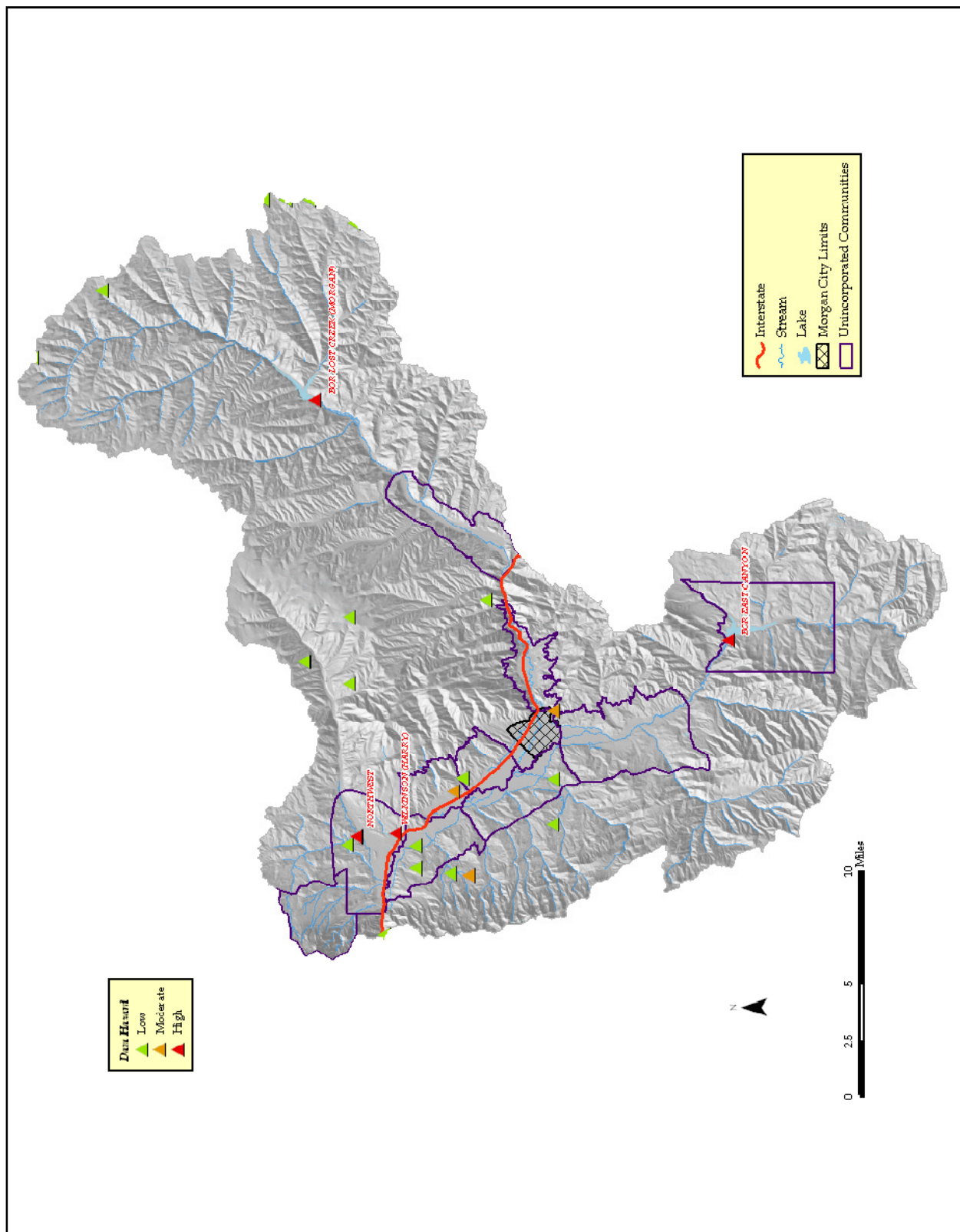
Item	Length (Miles) or Number of Units	Replacement Cost
Highways/Interstates	1.16 miles	\$9,985,771
Highway Bridges	3 bridges	\$629,324
Railway Segments	1.13 miles	\$1,300,443
Railway Bridges	0 bridges	\$0
Water Distribution Lines	N/A	N/A
Gas Lines	N/A	N/A
Sewer Lines	N/A	N/A
<i>Total Estimated Infrastructure Replacement Cost</i>		\$11,915,538

Table 10-19. Infrastructure Vulnerable to Dam Failure, Morgan County

Incorporated	Acres in Hazard Area	Population in Hazard Area	Number of Structures in Inundation Area	
			Residential Units (Replacement Cost)	Commercial Units (Annual Sales)
Morgan	74	231	73 \$14,819,000	0

Unincorporated	Acres in Hazard Area	Population in Hazard Area	Number of Structures in Inundation Area	
			Residential Units (Replacement Cost)	Commercial Units (Annual Sales)
Croydon	4,298	84	28 \$5,684,000	3 \$467,080
East Canyon Resort	0	0	0	0
Enterprise	2,355	209	69 \$14,007,000	1 \$5,301
Milton	2,822	690	230 \$46,690,000	1 \$12,489
Mountain Green	4,166	1,267	401 \$81,403,000	18 \$4,060,753
Peterson	3,658	440	156 \$31,668,000	2 \$1,798,602
Porterville/Richville	6,753	694	226 \$45,878,000	4 \$376,274
Round Valley	2,248	213	79 \$16,037,000	3 \$1,103,913
Snow Basin Resort	0	0	0	0
Stoddard	1,767	188	61 \$12,383,000	1 \$448,400

Table 10-20. Dam Failure Vulnerability, Morgan County



Map 10-9. Dam Hazard Map, Morgan County (Utah Division of Water Rights 2007)

Hazards and Future Development

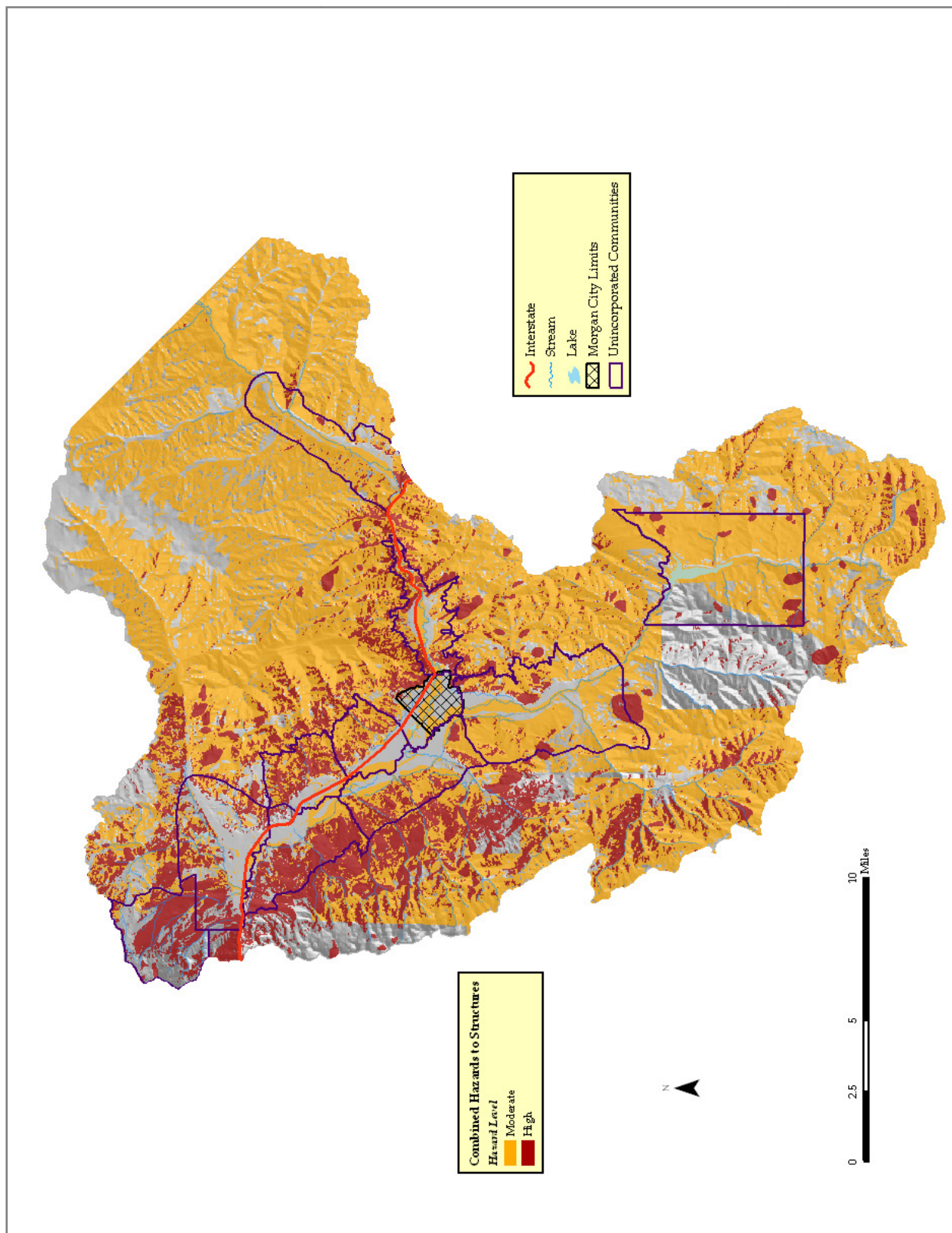
Census Population Estimates									
MCD/ County	2000 Pop (July 1 est.)	2006 Pop (July 1 est.)	Absolute Change 2000- 2006	% Change 2000- 2006	AARC 2000- 2006	Rank by 2000 Pop	Rank by Absolute Change	Rank by % Change	Rank by AARC
Morgan County	7,181	8,888	1,707	23.8%	3.6%	22	14	6	13
Population by County and Multi-County									
MCD/ County	1980	1990	2000	2010	2020	2030	2040	2050	AARC 2000- 2050
Wasatch Front	941,172	1,104,356	1,389,252	1,665,238	1,966,372	2,207,282	2,429,057	2,654,682	1.3%
Morgan County	4,950	5,561	7,181	10,183	16,200	24,595	34,290	46,596	3.8%
Households by County and Multi-County									
MCD/ County	1980	1990	2000	2010	2020	2030	2040	2050	AARC 2000- 2050
Wasatch Front	298,700	357,257	449,844	507,463	668,786	780,369	870,671	960,756	1.5%
Morgan County	1,355	1,555	2,069	3,229	5,514	8,639	12,341	17,117	4.3%
Table 10-21. Demographic and Economic Projections (UPEC 2007, 2008) All statistics are based on July 1 snapshot. AARC = Average Annual Rate of Change									

Morgan County is experiencing rapid residential development. Since July 2000, Morgan County has seen a 25% increase in residential housing (BEER 2007). Many have been built in extremely hazardous areas for landslide and wildland fire.

To assist its citizens in becoming less vulnerable to the landslide hazard, Morgan County enacted an ordinance requiring geotechnical studies to be performed prior to new construction. The County's General Plan restricts construction on slopes greater than 25 percent and requires grading standards for hillside development.

With the adoption of the 2006 Utah Wildland-Urban Interface Code, Morgan County is now better prepared to mitigate the potential for wildland fires affecting development within the County. The new codes give more power to building code enforcement to ensure necessary provisions are made for access, water supply and defensible space in the event of an actual fire. In some instances, the code enforcement officials have the authority to require fire protection plans to ensure property owners are sufficiently prepared.

Map 10-10 (page 180) shows the combined risk of nine structurally-threatening hazards (dam failure, earthquake, flood, landslide, lightning, problem soils, tornado, wildland fire and wind) in Morgan County. The areas of high hazard (red) are areas of high landslide and flood risk as well as the "extreme" risk wildland fire areas. These areas are best preserved as open space to protect citizens from almost certain disasters. The moderate areas of the map (orange) are those areas having moderate or greater risk from five (5) or more structurally-threatening hazards. These areas should be preserved as open space if not already developed or hazard-appropriate development is encouraged. If already developed, these areas should be the initial focus of education campaigns and for regulatory requirements of hazard mitigation techniques by residents.



Map 10-10. Combined Hazards to Structures, Morgan County

Mitigation Strategies

The following mitigation strategies were formulated at a meeting for the Morgan County Mitigation Strategies Working Group on September 5th, 2007, at Morgan County Emergency Services. The Working Group sought to refine and expand on efforts already in place. Information on Working Group members can be found in Part III.

Dam Failure

Problem Identification: Federal, state, and private dams can impact Morgan County. Morgan County has poor community awareness and response systems.

Goal - Reduce loss of life and limit damage to property

Objective (Priority MEDIUM): Increase community awareness of dams that could impact the County

Action #1: Educate community of evacuation routes
Time Frame: 1-2 years
Funding: County
Estimated Cost: Minimal
Staff: Emergency Management

Action #2: Tie dam failure notification system to reverse 911
Time Frame: Over the next five years
Funding: Unknown
Estimated Cost: Undetermined
Staff: Emergency Management

Drought

Problem Identification: The residents of Morgan County are unaware of the water conservation options that are available to them.

Goal - Decrease the impact of drought on the community

Objective (Priority LOW): Develop and promote water conservation measures.

Action #1: Promote water conservation utilizing the Drought Contingency Plan
Timeframe: Immediate
Funding: County/Grant
Estimated Cost: Minimal
Staff: Emergency Management, Contract, Soil Conservation, Extension

Action #2: Promote the use of the secondary water system
Timeframe: Immediate
Funding: Secondary Water Board
Estimated Cost: Minimal
Staff: Secondary Water Board, Emergency Management, Morgan City

Earthquake

Problem Identification: Critical facilities (public safety, commercial buildings, and schools) need to be made less vulnerable from the impact of earthquakes to allow a more timely response and to decrease the impact to lives.

Goal – Reduce loss of life and damage to property

Objective (Priority HIGH): Decrease the negative effect of earthquakes within the County

- Action #1: Begin an earthquake awareness campaign to include awareness of availability of earthquake insurance
Time Frame: 6 months – 1 year
Funding: County
Estimated Cost: Minimal
Staff: County Emergency Services, Community Services Director
- Action #2: Facilitate a pre-earthquake damage assessment to evaluate critical facilities in need of retrofitting and the design criteria for the new county building
Time Frame: Immediate – 1 year
Funding: Grants, general fund
Estimated Cost: Undetermined
Staff: City/County Engineers, Consultant, Building Official
- Action #3: Work with the County businesses to ensure proper earthquake preparedness training
Time Frame: 1-5 years
Funding: County / Grant
Estimated Cost: Minimal
Staff: Emergency Management, Community Services Director

Flood

Problem Identification: Morgan County has two major streams (East Canyon, Weber) and several smaller ones that threaten communities during spring runoff.

Goal #1 – Lessen impacts from flooding

Objective #1 (Priority HIGH): To reduce flood threat to Morgan County

- Action #1: Maintenance of channels and bridge openings
Time Frame: Immediate
Funding: Routine maintenance
Estimated Cost: Minimal
Staff: County Road Department
- Action #2: Work with water conservation districts, state legislators and other state agencies to increase flood storage area
Time frame: 2-3 years
Funding: Unknown

Estimated Cost: Unknown

Staff: Emergency Management, County Engineer, State Floodplain Manager

Action #3: Advise residents and develop outreach materials on the availability of flood insurance

Time Frame: Immediate

Funding: County

Estimated Cost: Minimal

Staff: Emergency Management, County/Morgan City Floodplain Administrators, State Floodplain Manager, Community Services Director

Action #4: Enact land use ordinances to preserve floodplain/open space due to increasing development pressure in floodplain areas. Pursue open space preservation in planning practice and floodplain development regulation.

Time Frame: 1-2 years

Funding: Minimal

Estimated Cost: Minimal

Staff: Community Development Department

Action #5: Form storm water improvement district for storm water disposal

Time Frame: 1-2 years

Funding: Grants, taxes

Estimated Cost: Undetermined

Staff: County Engineer

Goal #2 – Reduce threat of unstable canals throughout the County

Objective #2 (Priority HIGH): Identify countywide canal systems

Action: Map and assess the structural integrity of canal systems in the County. Determine the vulnerability of persons and infrastructure.

Time Frame: 1 year

Funding: Federal grants

Estimated Cost: Unknown

Staff: County/City Public Works, Canal Companies, County Engineering, County GIS

Severe Weather

Problem Identification: Snowstorms, hail, thunderstorms, lightning, heavy rain, wind and avalanche impact Morgan County. This is intensified by Morgan County's remote location.

Goal #1 – Assist in protecting residents from the effects of severe weather

Objective#1 (Priority MEDIUM): Lessen the impact of severe storms to residents and businesses within Morgan County

Action #1: Increase residents' awareness of the need for food storage for use during severe storms.

Time Frame: 1-3 years

Funding: County, grants
Estimated Cost: Minimal
Staff: Emergency Management, Extension

Action #2: Increase residents' awareness of where emergency shelters are located
Time Frame: 1-3 years
Funding: County, grants
Estimated Cost: Minimal
Staff: Emergency Management/Contract

Action #3: Establish the county in the National Weather Service Storm Ready program
Time Frame: 1 year
Funding: County
Estimated Cost: Minimal
Staff: County Emergency Management, NWS, DHLS

Action #4: Encourage avalanche preparedness for county backcountry users
Time Frame: 1 year
Funding: Minimal
Estimated Cost: Minimal
Staff: County Emergency Manager, State Hazard Mitigation Team, Utah Avalanche Forecast Center.

Slope Failure

Problem Identification: Morgan County has a significant landslide threat. The community of Mountain Green and Trappers Loop Road (Highway 167) as well as critical pipeline routes can be impacted by landslides.

Goal #1 – Avoid risk or exposure to landslides through informed planning and zoning decisions

Objective #1 (Priority HIGH): Provide citizens with updated geologic hazards maps and information

Action: Educate officials, landowners, and developers about geologic hazards
Time Frame: 1-2 years
Funding: None
Estimated Cost: None
Staff: County Engineer/UGS

Objective #2 (Priority HIGH): Monitor historical landslide areas

Action #1: Expand scope of mapping to identify active landslides and potential landslides
Time Frame: Unknown
Funding: Federal Grants
Estimated Cost: Unknown
Staff: Emergency Services, County Engineer, UGS, USGS

Action #2: Develop and implement long term landslide hazard mitigation measures along the Gateway Canal.

Time Frame: 2-5 years
Funding: PDM Grants, Weber Basin Water Conservancy District (WBWCD), U.S. Bureau of Reclamation
Estimated Cost: Unknown
Staff: WBWCD, Bureau of Reclamation

Goal #2 – Use land use ordinances to reduce the risk of slope failure to public and private property

Objective (Priority HIGH): Enact land use ordinance

Action: Present to County/City Councils for adoption
Time Frame: 1 year
Funding: Local funds
Estimated Cost: Unknown
Staff: County Engineer, County Planner, UGS

Wildfire

Problem Identification: Continuing non-compliance with existing building codes and fire codes

Goal #1 – Building and fire code compliance

Objective (Priority HIGH): Increase compliance with existing building and fire codes.

Action: Continue to enforce current local, state and national codes.
Time Frame: Ongoing
Funding: Local, state and federal grants
Estimated Cost: Unknown
Staff: Local, state and federal agencies

Goal #2 – Wildfire community education

Objective (Priority HIGH): Reduce overall risk from wild fire through education programs - especially in Mountain Green, Trappers Loop, the area east of Porterville, and East Canyon.

Action: Public awareness through "Fire Wise" programs.
Time Frame: 2-3 years
Funding: Unknown
Estimated Cost: Unknown
Staff: Fire Departments, Utah Living With Fire, US Forest Service and UFFSL